REFERENCE TOOLS

PAC FOOD case studies report at pac.ca/Programs/FW/Documents, and INTELLIPACK member case studies at pac.ca/Programs/intellipack/CaseStudies.cfm provide information on in-market smart packaging applications and delivered benefits. Examples of the types of Smart Packaging are shown below.

QR Codes/Bar Codes:

Allows for smartphone camera scan and access to Internet information. QR codes provide a unique product identity for traceability, authenticity and consumer loyalty.

Smart Inks/Pigments:

React to changes in the environment (heat, cold, UV light) and can enhance package branding, indicate freshness and quality.

Modified Atmosphere Packaging (MAP):

In combination with barrier films or added strips helps extend fresh produce shelf life.

Smart Sensors:

Smart control systems for MAP that react when exposed to oxygen e.g. luminescent dot that lights up. Confirms food freshness and quality.

Digital Watermarks:

Covertly embedded directly into the print design of a package. Codes are unique and scanned by smartphone to provide product information and confirm authenticity.

Smart Indicators:

The Timestrip can be an indicator for product freshness or for cold chain logistics to help reduce product loss and wastage.

Augmented Reality:

Uses technology to superimpose virtual reality onto packaging to improve branding, interactions with consumers.

RFID Tags:

An electronic tag that exchanges data with an RFID reader through radio waves. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. Active tags have a local power source (such as a battery) and may operate hundreds of meters from the RFID reader.

NFC Tags:

Near Field Communication is a subset of RFID that facilitates consumer interaction (vs logistics and supply chain tracking with an RFID tag) as the NFC tag can be read by a smartphone when in close proximity (ca. 4cm)"

IN MARKET EXAMPLES

Smart packaging plays an important role in preventing food waste. Some fresh produce packaging features micro-perforated lidding film and gas permeable labels that helps extend shelf life such as an extra 12 + days for tomatoes. while maintaining the recyclability of the packaging.

Smart packaging equally plays an important role in product traceability, authenticity, anti-counterfeiting and product & package information. In this example for pharmaceuticals a smartphone and an accompanying app reads the QR code on the CapSeal cap, which is then compared with a database to determine the authenticity of the product within seconds.

ADDITIONAL RESOURCES

Designing environmentally friendly smart packaging:
RFID has the potential to be a significant enabler in the recycling of various types of products according to ISO/IEC TR 24729-2:2008 iso.org/standard/41882.html. The standard is also concerned with the prevention of solid waste generation by the tags themselves. Proper disposal is especially needed for active tags, since their internal power source is often a lithium battery.

RAND Europe published a report in 2012 "SMART TRASH - Study on RFID tags and the Recycling Industry" The study, funded by the European Commission, aimed to obtain expert input necessary for assessing (i) the environmental impact of RFID tags and (ii) the environmental advantages that RFID can provide for product lifecycle management.

The Future of environmental friendly NFC tags:
gototags.com/blog/the-future-of-environmentally-friendly-nfc-tags/

Design for Recycling
PAC NEXT structural packaging sustainability checklist provides a quick reference guide for better packaging design sustainability decisions.pac.ca/Programs/Next/Documents/pac-packaging-sustainability-checklist-structural.pdf

Association of Plastic Recyclers (APR) Design for Recycling Guidelines for plastics packaging:
plasticsrecycling.org/apr-design-guide/design-guide-resources

Inks (Nestle Guidance on Packaging Ink, August 2016)
argus-analysen.de/assets/plugindata/poola/nestle-guidance-note-on-packaging-inks-2016-08.pdf

TRADE-OFF CONSIDERATIONS

What if the use of smart packaging results in trade-offs or unintended consequences (e.g. higher costs, less recycling, poorer brand positioning)?

It is important to align and integrate your smart packaging decisions into your mainstream package design and development program and to understand upfront the potential trade-offs on costs, efficiencies, brand connectivity or product benefits communication and sustainability. Focus on how the smart packaging can enhance your long term sustainability goals and through collaboration and innovation your chances of success will increase.

How do I balance sustainability with important smart packaging considerations?

The answer here is to take a holistic approach, in most instances smart packaging will improve product and package sustainability by extending shelf life, reducing loss and wastage, increasing logistics efficiencies and providing more useful product and brand information to consumers more readily through smart devices.

RECYCLING WATCH OUTS

Smart packaging often involves adding an additional element to the existing packaging that can impact the recyclability of this package:

Smart Material choices: Common package materials (PET, HDPE, LDPE, PP, Paper, Carton) are more likely to be accepted at curbside collection programs. Matching smart materials with primary package materials will avoid contamination issues and retain the higher value of the primary recyclable material.

Smart Label, Films, Sleeves: Where feasible design all of these items for recyclability so that the entire package can be recycled.

Smart Inks & Pigments: Smart Inks & Pigments: Ensure ink bleed tests are conducted to avoid any potential contamination of plastic and paper recycle.

Lithium Batteries: Where feasible should be easy to remove from the packaging and disposed of separately. They represent a potential safety risk in MRF's if compacted in bales of flammable materials.

SMART PACKAGING SUSTAINABILITY CHECKLIST

A WORLD WITHOUT PACKAGING WASTE

The Smart Packaging Community

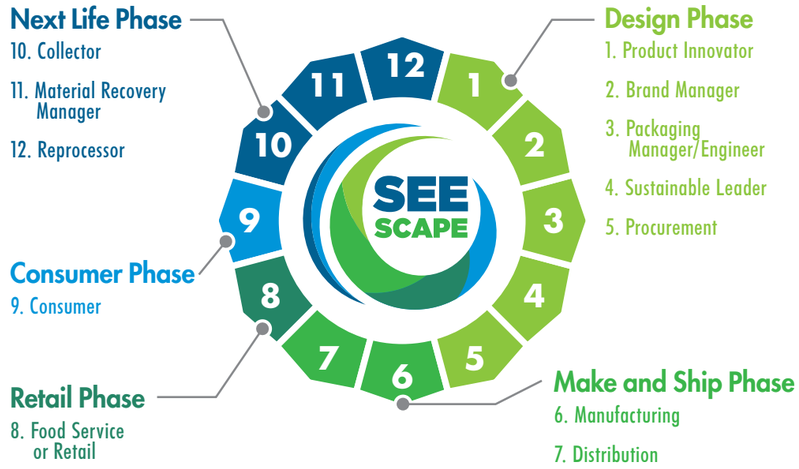
This checklist is intended for the smart packaging community and those interested in using smart packaging for their products and packaging who want to understand the potential environmental impacts of smart packaging.

Smart packaging is an active or intelligent interactive packaging system that provides benefits beyond containment and protection of the product. This may include the ability to control the inner atmosphere of a package, sense or measure an attribute of the product, or communicate information e.g. consumer, retailer, brand, logistics, authenticity, quality or aiding in product & packaging recycling and recovery. See Reference tools on back page for examples of different types of Smart Packaging.

Smart Packaging and The Circular Economy – The Circular Economy is restorative and regenerative by design. This approach is reshaping the traditional model of **"take-make-dispose"** in order to design waste out. Smart packaging presents a tremendous opportunity to leverage smart materials and technology to close the loop for more efficient product and packaging reuse and recycling.

The Collaborative Team

The **PAC SEESCAPE MODEL** represents a collaborative team of stakeholders throughout the packaging value chain who play a key role in designing for packaging and smart packaging systems sustainability. Everyone has equal status. The team's objective is to leverage the smart packaging technology to keep traditional packaging as a valuable resource in a continuous closed loop system and have no unintended consequences on the existing recovery systems and infrastructure.



The Checklist

This checklist provides a quick reference guide to help you make more informed sustainability decisions for smart packaging. Before you begin, ask yourself:

- **How can smart packaging impact the sustainability goals of my company and customer?**
- **How can smart packaging drive more sustainable and circular packaging designs?**
- **How could the materials in my smart packaging adversely impact recovery?**
- **Do I have all the information I need to make the right choices?**

1. **SMART SAFETY**
2. **REUSE & RECYCLABILITY** — What will the packaging material(s) be made from?
3. **SMART FUNCTIONALITY** — Does the system provide a better experience?
4. **PRINTING ADDITIONS**
5. **FILMS, LABELS, & SLEEVES** — How will the package be discarded for its next life?
6. **SMART ELECTRONICS** — What tools are needed to access product information?

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SMART SAFETY

1. Does the smart packaging pose any risks toward human or environmental health?
2. If the smart packaging substrate uses precious metals (e.g silver) are there concerns regarding leaching of components in landfill or recycling facilities?
3. If used for food applications, is the material approved for direct or indirect food contact?
4. Does the smart packaging use lithium batteries? Do they represent a safety risk as a potential heat source after use?
5. Are there extra materials or components that are unnecessary?

✔ **Take** a holistic and intuitive approach and consider impacts of smart packaging on the entire product-packaging system to ensure product performance, stability and safety.

✔ **Confirm** that smart packaging complies with packaging and printed electronics regulations (CONEG, RoHS, REACH, ISO / IEC) and FDA food contact regulations.

✔ **Consider** impacts from batteries or power sources on the recycling stream. Ensure that they can be easily removed from the package. Provide guidance on safe disposal or recycling of the batteries. Lithium batteries should NOT go into Blue Bins but should be taken to recycling centers.

2

REUSE and RECYCLABILITY

1. Is the smart packaging or material recyclable or non-recyclable? Reusable or compostable?
2. Is the smart package designed for disassembly or for product & package compatibility? Is the packaging unnecessarily complex?
3. Can the smart package include the capability to be scanned or recognized by consumers or MRF's to facilitate better sortation of materials?
4. Does the packaging clearly identify the material(s) used? Is it marked with the revised plastic resin identification code, where applicable?

✔ **Consider** impacts throughout the packaging value chain, including at Material Recovery Facilities (MRFs), where materials are sorted for recycling.

✔ **Check** with industry sources to understand potential recycling impacts e.g. the Association of Plastic Recyclers (APR), the Institute of Scrap Recyclers Industries (ISRI), Biodegradable Products Institute (BPI), intelliPACK

! *Design for disassembly for packaging with multiple components, including retail displays and other promotional packaging, in order to increase chances of packaging being successfully and safely recovered.*

! *Design for compatibility – it may be possible to select materials that are the same as the primary package to enable recovery and recycling.*

✔ **Monitor** emerging technology that would allow smart packaging to assist with improved recycling sortation of materials (e.g. digital watermarks). Refer to the Intellipack website for updates.

✔ **Communicate** to consumers what to do with each packaging component at the end of life. (Refer to How2Recycle program and local WEEE program)

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SMART FUNCTIONALITY

1. Does the smart packaging provide an added benefit or better experience (product tracking, traceability, authentication, consumer/retailer interaction, how to recover and recycle)?
2. What tools will the consumer or retailer need to access the product information? (e.g. mobile phones, smart watches / wearable, smart appliances / scanners)
3. Does the smart packaging inform the consumer about the interactivity / how to engage?

✔ **Communicate** to consumers – understand how the smart packaging communicate functions can be used to help consumers make informed decisions about product quality, safety, brand info. AND recycling.

✔ **Communicate** to retailers – ensure communication functions help retailers with product tracking, logistics, traceability, authentication, product quality, safety AND recycling. Understand how this capability can reduce product losses and increase product shelf life.

✱ *Smart Appliance Apps – ensure that the smart packaging enhances Smart appliance access to product and package information. Important for e-commerce where most of the marketing and purchase decisions are made on-line.*

✔ **Consider** providing additional information online or via a smart phone app to reduce the amount of printing or packaging required.

4

PRINTING ADDITIONS

1. Does the packaging include use of smart inks (light or heat sensitive) or adhesives that may compromise the value of recycled materials?
2. Do the printing inks, adhesives or coatings used raise any concerns? (leaching into materials / environment)

✔ **Ensure** selected inks & pigments (for labels and paper substrate) do not bleed in water as this may degrade the quality of recyclate. Also check that barrier coatings and label adhesives used are recycling friendly (refer to APR - Association of Plastic Recyclers Design Guide for Plastics Recyclability and Bleeding Label test).

✔ **For** food packaging, test to ensure that ink chemicals do not migrate into the contained product. Smart inks are often used to improve food safety and to help reduce food loss & waste.

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FILMS, LABELS, and SLEEVES

1. Do the labels, strips or films used in the smart packaging adversely impact recovery and are they difficult to remove?

✔ **Where** feasible, design all of these items for recyclability (common materials to primary packaging) so that the entire package can be recycled.

✔ **Design** the package for dis-assembly for easy removal of labels, strips, films to minimize contamination of the primary packaging.

✔ **Use** body sleeves that are compatible with recycling, use perforations to encourage removal or have de-seaming adhesives that enable easier sleeve removal (APR Critical Guidance Test for Sleeve Labels).

✔ **Where** labels and sleeves cannot be removed from the primary package ensure that they comply with APR guidelines for substrates and adhesives to minimize contamination of high value recyclable materials (HDPE, PET) .

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SMART ELECTRONICS

1. Do the sensors or tags (e.g. RFID, NFC) used in the smart packaging adversely impact recovery and are they difficult to remove?
2. How will the sensors and tags be recovered post-use?

✔ **Design** the package for dis-assembly – easy removal of the sensors and tags to minimize contamination of the primary packaging. Understand options to ensure safe disposal or recycling of components. RAND report (see Additional Resources) indicated that likely best option is for RFID tags to be disposed of with WEEE (Waste Electrical & Electronic Equipment.)

✔ **Design** the sensors and tags for recyclability so that the entire package can be recycled. For example, some paper based RFID tags may be recycled with the corrugated or paper stream. Where possible use certified paper sources e.g. FSC certified. Consider eco friendly hot melt adhesives and alternates to metal antennas.

✔ **Follow** latest technology developments for environmentally friendly tags e.g. Smartrac.

✔ **Refer** to industry standards for printed electronics (IPC Association Connecting Electronics Industry, ASTM electronics standards, IEC - International standards for printed electronics.

The Smart Packaging Sustainability Checklist was developed in collaboration with intelliPACK: a partnership between PAC and intelliFLEX.